PHYTOPATHOLOGY

VOLUME V NUMBER 4

AUGUST, 1915

ROOT ROT OF CONIFEROUS SEEDLINGS

ARTHUR H. GRAVES

WITH TWO FIGURES IN THE TEXT

Authenticated cases of death of trees from root rot caused by lack of oxygen in the soil, i.e., from asphyxiation, are not common. Hartig[1] has described an example of such a condition occurring in young thirty-years-old Scotch pines in Germany, where, according to him, circulation of air in the soil became more and more restricted due to conditions incident to forest growth, resulting eventually in the practical exclusion of air from an argillaceous substratum.

The writer has seen cases of large tulip trees, *Liriodendron tulipifera* L., dead from this cause near Lakes Toxaway and Fairfield, North Carolina. Both of these lakes are of quite recent artificial origin, and it is probable that by their formation the water table in the immediate vicinity was so raised that the roots of the tulips in question were drowned out.

The suffocating effect of piling large quantities of earth upon the roots of trees during building or road cutting operations is becoming better understood in this country, as evidenced by the increasing number of cases where "wells" are built around such trees in order to provide for the maintenance of an air communication with the roots.

In the diagnosis of tree diseases, one is often tempted, when a visible cause is not apparent, to locate the seat of the trouble in the roots. But in large trees an examination of the roots for direct evidence is usually difficult. With young seedlings, however, the case is different, and on this account the trouble about to be described in this paper deserves notice.

The disease in question appeared in the nursery of the Yale Forest School during the spring and early summer of 1914, and was particularly

[1] Hartig, Robert. Text-book of the diseases of trees, pp. 276–278. English Ed. 1894.

destructive. Besides the loss of about twenty per cent of a bed of one-year-old red pines, *Pinus resinosa* Ait., and five per cent of a bed of one-year-old white pines, *Pinus strobus* L., several thousand two-years-old red pines succumbed, as well as a few seedlings of one-year-old hemlock, *Tsuga canadensis* (L.) Carr.

The disease first became noticeable through a dark red or reddish brown coloration of the tips of the leaves. In the initial stages the contrast of this dark red color with the remaining deep green of the leaves was very striking. By slow degrees, extending over an interval of several weeks, the red color extended throughout the entire leaf to its base. Subsequently the reddish hues changed usually to browns, or yellow-browns, and the final color was, in most cases, some shade of yellow, although often intermixed with reddish tints.

A long period—at least a month—was required for this sequence of color changes; and, at the end of this time, in case the disease had proved fatal, the whole plant was stiff, dry, and entirely dead.

When the disease was first critically examined, early in May, it was suspected that the leaves had sustained a fungous trouble of the nature of the well known *Schüttekrankheit*, both because of their discoloration as well as from the fact that the diseased plants appeared to be located in more or less irregular patches scattered throughout the beds. However, examinations of the discolored leaves, even on plants where the disease had progressed far, failed to disclose any fruiting bodies or mycelium of a fungus, nor did incubation succeed in bringing to light any pathogenic form.

It was evident that the patches of diseased seedlings were almost always situated in slightly sunken portions of the beds, as well as along their margin, where drainage was poorest.

Diseased seedlings which had been carefully uprooted revealed a root system that was almost without exception entirely dead. This was the case even when the leaf discoloration had not yet started in, the only evidence of trouble being in the failure of the terminal bud to unfold and develop the leaves of the year (fig. 2). These conditions, joined to the fact that where the discoloration had appeared it uniformly commenced at the *tips* of the leaves, clearly indicated a root trouble of some sort.

That this root trouble was not of fungous origin, but was due primarily to unfavorable soil conditions, was borne out by the following considerations:

1. Repeated attempts to isolate from the roots a pathogenic fungus or fungi as causal organisms in the disease were always attended with negative results. These experiments consisted of (1) incubation in moist

chambers, of roots which had recently died, (2) insertion of the inner portions of diseased roots, removed with a sterile scalpel, in nutrient agar, and (3) placing such roots, whole, in nutrient agar. In every case no forms appeared except saprophytic fungi, and bacteria which were presumably saprophytic. One fungus, which was kindly identified by Mrs. Flora W. Patterson, *Cylindrocladium scoparium* Morgan,[2] was of

FIG. 1. One-year-old seedlings of Pinus resinosa, showing recovery from root rot. A new, healthy, whitish root shows in each case. Shoots commencing a belated growth. In the figure to the right the new root has just started from the base of the stem.

such general occurrence that it was viewed with suspicion, but inocu'ations of healthy seedlings in sterilized soil with this form gave only negative results.

2. The soil of the seed beds was stiff and clayey, and although a considerable amount of leaf mould had been added to it, there was still a

[2] Morgan, A. P. Two new genera of Hyphomycetes. Bot. Gaz. **17**: 190–192. 1892.

very small proportion of humus. As a consequence its porosity was slight, and in rainy periods the water would stand for some time in the hollows and poorly drained parts. Such conditions would naturally prevent a free access of oxygen to the roots, and would therefore readily promote root rot.

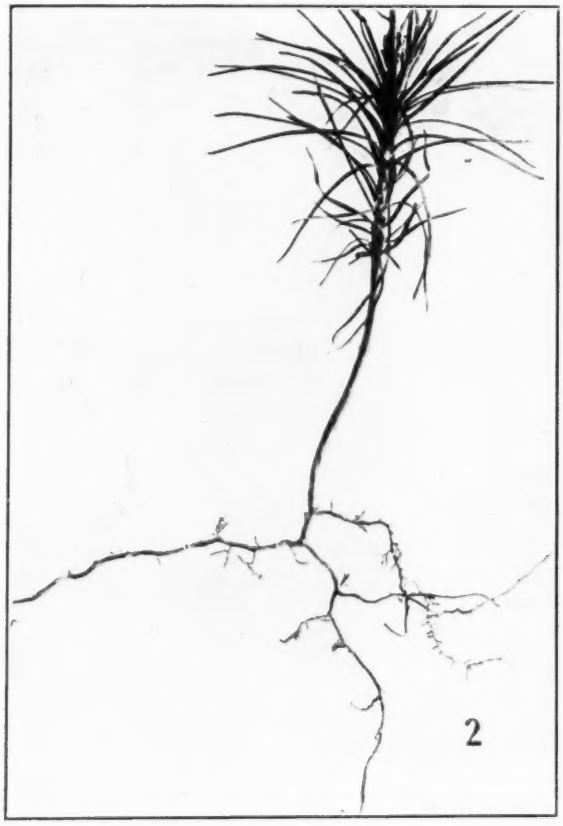

FIG. 2. Seedling of Pinus resinosa. Roots entirely black and dead. Top still alive, but no growth evident.

3. The disease caused most havoc during the months of March and April, when the soil was still soggy from the winter freeze and rains, and when the roots, on the other hand, stood in the greatest need of oxygen for the commencement of metabolic activities incident to the season's growth.

4. In June and July, when the soil conditions were much improved over those of early spring, many cases of recovery from the disease were observed, as shown by the fact that new roots had developed in the region

of the root collar (fig. 1). At this time seedlings which were recovering and forming new roots could be detected very often by a glance at the tops. If these were starting a belated growth, inspection of the root system in every case would reveal usually one or sometimes more new roots, conspicuous by reason of their white color, their thickness, and origin high up, near the base of the stem (fig. 1). Such recovery, which was of fairly common occurrence, is more in line with a physiological trouble, than a disease caused by a parasitic fungus.

5. The course of the disease was slow, requiring at least a month for its completion. In many cases, even after three months of growth, i.e., about August, the tops still appeared healthy, although the year's growth had not developed, and examination of the roots showed them to be apparently dead. Here a considerably longer period would have been necessary before the plants entirely succumbed. A very gradual death of this sort would not be expected if the trouble were due to the attack of a parasitic fungus.

6. In soil of a similar character, in another part of the nursery, which had been thoroughly limed, and contained a generous amount of humus, such a disease had never been known to occur. This soil was loose and porous, never retaining water on its surface for any length of time.

The conclusion is therefore that the disease was due to lack of oxygen trouble in a soil which was saturated with water; i. e., that the roots were suffocated.

As already intimated, the remedy would consist in a thorough liming of the soil. Probably this in itself would be sufficient, but the addition of more humus would also improve the physical character of the soil as well as benefit the plant growth directly.

NEW HAVEN
CONNECTICUT

TELIAL STAGE OF GYMNOSPORANGIUM TUBULATUM ON JUNIPERUS SCOPULORUM

JAMES R. WEIR

The original collection of the aecial stage (*Roestelia tubulata* Kern) of *Gymnosporaginum tubulatum* Kern was made by Marcus E. Jones[1] on *Crataegus douglasii* Lindley near Flathead Lake in Montana. Apparently no clue to the telial stage was found at the time, neither has it been experimentally determined since that date.

In the vicinity of Missoula, Montana, the aecial stage of this Gymnosporangium, as determined from material sent to Dr. F. D. Kern, for the past few seasons, has been so very abundant on *Crataegus douglasii* that it annually causes a premature falling of the leaves of its host. It was observed that the worst cases of defoliation were in close proximity to juniper trees of the species *Juniperus scopulorum* Sargent, whose branches and twigs were thickly covered with irregularly lobed telial galls. This seemed to indicate that this juniper is the alternate host of the fungus, a suspicion which has been experimentally proved by the following method. In early spring before the leaves of the haw appeared, a glass tube two feet long and two inches in diameter was placed on a section of a branch of a tree in a part of the Missoula valley where the rust does not occur and firmly tied in position. The ends of the tube were thoroughly plugged with surgeon's absorbent cotton and protected from the direct rays of the sun. As soon as the leaves were sufficiently unfolded inside the tube, one of the plugs was removed, the leaves were thoroughly sprayed with water containing germinating teliospores from the galls on the juniper, and the plug was replaced. The teliospores were taken from galls which had gelatinized in the laboratory. After nine days the leaves bore the pycnial stage, and before two months had elapsed the aecial stage appeared in such abundance that the leaves became very much deformed. Only the leaves covered by the tube were infected. This proves beyond doubt that *Juniperus scopulorum* bears the telial stage of *Gymnosporangium tubulatum*. The aecial form is chiefly foliicolous although the fruit of the host is often seriously infected.

INVESTIGATION IN FOREST PATHOLOGY
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[1] Montana Botany Notes. University of Montana Bul. 61:64, 1910.

THE AFTER EFFECT OF SULFUR TREATMENT ON SOIL

C. D. Sherbakoff

With Three Figures in the Text

The after effects of sulfur treatment on soil for the control of potato scab has received brief consideration by various investigators. Halsted[1] found that an application of 720 pounds of sulfur per acre reduced the succeeding crop of potatoes nearly half. Wheeler, Hartwell and Moore[2] found a marked reduction in the yield of two cereals, oats and millet. Their experiments were performed in large size pots, not in the field. Demolon[3] reports that a dosage of 80 grams (kilograms ?) of sulfur per hectare had an injurious effect on cereals when used on a soil poor in calcium. He attributes the injury to too strong acidification of the soil.

The writer[4] has reported on an extensive field experiment in which on two succeeding years, areas of considerable extent were divided into test plats and treated with sulfur in varying combinations and quantities. Briefly stated the plan of the experiment is as follows:

A field was divided into equal parts and each part again divided into plats measuring 182.5 feet by 12 feet. Potatoes were grown on both parts in 1912 and in 1913. One part was treated in 1912, the other was treated in 1913. The experiment was performed in replication and was abundantly checked by untreated plats. The special treatments of the plats were as follows: (1) Sulfur alone, applied at the rate of 450 pounds and of 900 pounds per acre; (2) Sulfur at the rate of 450 pounds and of 900 pounds per acre in combination with lime at the rate of 350 to 400 pounds per acre and with commercial fertilizer (potash, 10 per cent, phosphoric acid, 8 per cent) 900 to 1000 pounds per acre; (3) the above amounts of lime and of commercial fertilizer per acre without sulfur.

In 1914 the field was sown to clover by the owner the seed being distributed broadcast. A marked difference was noted in the uniformity

[1] Halstead, B. D. Experiments with potatoes. New Jersey Agr. Exp. Sta. Rept. **18**: 276–284. 1898.

[2] Wheeler, H. J., Hartwell, B. L., and Moore, N. L. C. Upon the after effect of sulfur, when applied to soils for the purpose of preventing potato-scab. Rhode Island Agr. Exp. Sta. Rept. **12**: 163–167. 1899.

[3] Demolon, A. Recherches sur l'action fertilisante du soufre. Compt. Rend. Acad. Sci. Paris **156**: 725–728. 1913.

[4] Sherbakoff, C. D. Potato scab and sulfur disinfection. New York (Cornell) Agr. Exp. Sta. Bul. 350: 719–740. 1914.

of stand in the field. Certain narrow areas were practically bare and other areas produced a very poor stand. The field was left in clover and on June 1, 1915, the writer had an opportunity to examine it with the following results:

1. Wherever sulfur was used at the rate of 900 pounds per acre, whether the application was made in 1912 or in 1913, and whether the sulfur was used alone or in combination with lime or commercial fertilizer, there was a noticeably poorer stand of clover than on adjacent plats or there was no clover at all (fig. 1). The injurious effect of sulfur was most noticeable on that part of the field which was somewhat gravelly and

FIG. 1. In the centre of the figure is a plat treated in 1913 with sulfur at the rate of 900 pounds per acre. The plat on the left was treated with sulfur at the rate of 450 pounds per acre and the plat on the right received no treatment. The stand of clover varies markedly on the differently treated plats. Field sown to clover in spring of 1914, photograph made June 1, 1915.

relatively poor in humus. In one corner of the field where the soil is a good loam, rich in humus, there was practically no injury.

2. The plats treated with sulfur at the rate of 900 pounds per acre in combination with lime and with commercial fertilizer showed less of the injurious effects than where sulfur in this amount was used alone (fig. 2).

3. When sulfur was applied at a somewhat greater ratio than 900 pounds per acre, as was the case at the ends of the plats where the sulfur drill was turned, there was often no plant growth at all (fig. 3).

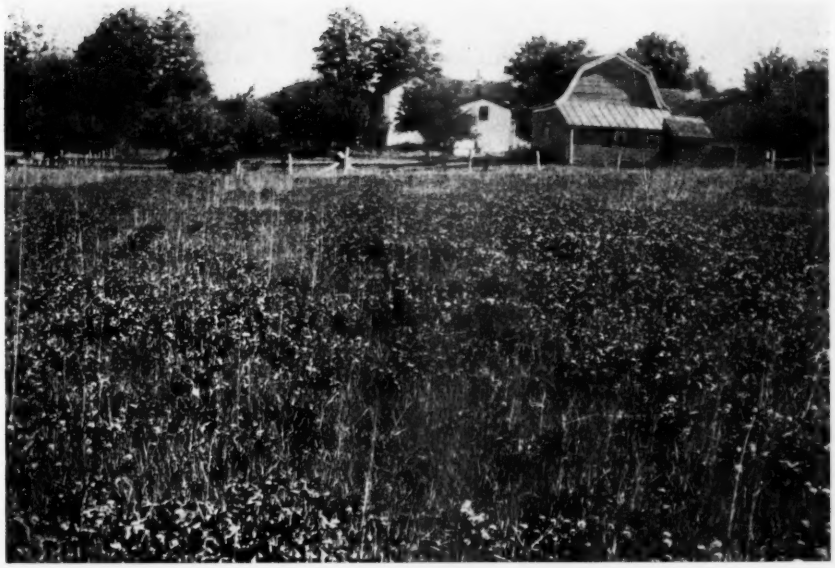

FIG. 2. In the centre of the figure is a plat treated in 1912 with sulfur at the rate of 900 pounds per acre and lime at the rate of 350 pounds per acre. The plat on the left was treated with lime alone at the rate of 350 pounds per acre and the plat on the right received no treatment. The contrast is not so marked as in figure 1, apparently on account of the lime used in combination with the sulfur. Field sown to clover in spring of 1914, photograph made June 1, 1915.

FIG. 3. An entirely sterile area in the clover field. This area lies just outside a plat treated in 1912 with 900 pounds of sulfur per acre and is the point where the sulfur drill was turned. The machine made a slow turn thus distributing an excess of sulfur.

4. The treatment with sulfur at the rate of 450 pounds per acre either alone or in combination, showed an injurious effect only in those parts of the field poor in humus and in no case was it as marked as where the larger quantity of sulfur had been used.

These observations are in accord with observations of a less extensive nature made in the spring of 1913. The entire field was seeded to a winter cover crop of rye in the autumn of 1912. The following spring there was a noticeable difference in the stand of rye on the variously treated plats.

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PERIDERMIUM PYRIFORME AND CRONARTIUM COMANDRAE

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Several contributions of late years on the subject of the Peridermiums have left unsettled the exact relationship existing between some of the well known species and their alternate hosts. Arthur and Kern,[1] in discussing the North American Species of Peridermium, make no mention of the alternate phase of *Peridermium pyriforme* beyond referring all Peridermiums upon pines to the genera Coleosporium and Cronartium for the telial condition. Arthur[2] in his treatment of the Uredinales in the North American Flora, states that the aecial condition of *Cronartium Comandrae* is unknown. In a recent paper, however, Arthur and Kern[3] have reached the inference that *Peridermium pyriforme* is the alternate phase of *Cronartium Comandrae*, basing their conclusion upon the coextensive distribution of the two supposedly distinct species of rust, and the fact that the species of Cronartium in question seemed to be the only unattached form. And finally the author is informed, though he has not had the pleasure of seeing the article, that Hedgecock and Long, in a privately printed paper, have recently published the results of observations whereby they are led to believe that *Cronartium Comandrae* is but the alternate phase of *Peridermium pyriforme*.

In May, 1912, a student brought to the botanical laboratory of the University of Montana, a piece of the stem of a young pine, apparently *Pinus ponderosa*, which bore, on a slightly swollen part, irregular, sinuous ruptures of the bark filled with the orange colored spores of *Peridermium pyriforme*. Inoculations with these spores were made immediately upon Comandra plants of the species *pallida* growing on a hillside near the University campus. Absence of the author from town for the whole of that summer involved the neglect of the plants so treated until his return in the fall, when the plants were found heavily infected with *Cronartium Comandrae* in the telial condition. However, as other plants for a distance of 100 feet around were likewise beset with the parasite,

[1] Arthur, J. C. and Kern, F. D. North American Species of Peridermium. Bul. Tor. Bot. Club **33**: 403–436. August, 1906.

[2] Arthur, J. C. Uredinales. North American Flora **7**: 83–160. March, 1907.

[3] Arthur, J. C. and Kern, F. D. North American Species of Peridermium on Pine. Mycologia **6**: 104–138. May, 1914.

misgivings were entertained as to the significance of the facts observed. At this time, early in October, telial columns of the Cronartium were used in an attempt to inoculate young trees of *Pinus ponderosa* growing in the nursery on the campus. Up to this date no apparent results have followed from this treatment, but this probably is due to the lateness of the season when the transfer was made.

Field observations supported the suspicion that *Pinus ponderosa* and *Comandra pallida* were the alternate hosts of the same fungus, for in the neighborhood of pines bearing Peridermium galls the Comandra, when present, is badly diseased with Cronartium, and the two host plants are very often and commonly associated.

Subsequent inoculations of the yellow pine made by the author at different times were not successful until last season, when in July, 1914, fresh spores from Comandra were inserted in incisions in the bark of the young pines. Sections prepared from some of the pine twigs at the points of inoculation now show distinct development of the hyphae in the wound; they ramify through the resin ducts and the intercellular spaces of the cortex, traversing the medullary rays to the cells of the pith, and extend up and down through the tracheids. Where the rays are occupied by the hyphae they become discolored, assuming a brown tinge. Comparing these sections with others made from twigs of pine known to be infected with the Peridermium reveals a condition similar in essential respects, as far as the hyphae are concerned, to that above described. Some structural peculiarities of the parasite are noticeable as well as its behavior with reference to the tissues, albeit galls have not yet formed.

Mr. E. E. Hubert, cooperating with the writer, in May, 1914, transfered spores of *Peridermium pyriforme* to pulp of crushed Comandra leaves and observed the production of the germ tubes. He also inoculated field plants with the spores and later found these plants infected with *Cronartium Comandrae*.

The above results are not regarded as conclusive, but as strong evidence that *Peridermium pyriforme* and *Cronartium Comandrae* are but the alternate phases of the same rust. Moreover, so far as the writer is aware, no records are published of the successful transfer of the parasite from Comandra to the pine, other than the results submitted herewith. Further experimental work on this subject is in progress, the results of which will probably be presented soon with fuller data.

Appreciation of the kindness of Prof. J. C. Arthur in the identification of material is hereby gladly expressed.

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METHODS OF INJECTING TREES

CAROLINE RUMBOLD[1]

WITH PLATE XIII

Experimental work on tree injections was started in 1912 by the writer when working on the chestnut bark disease. The Pennsylvania Chestnut Tree Blight Commission was responsible for the beginning of the work and the University of Pennsylvania has cooperated by offering facilities for the laboratory work.

The first injections were made in the roots of the chestnut trees. This method has been suggested by E. S. Goff[2] in a report on the effect of artificial root pressure on trees. It was soon abandoned. The time spent in digging around the trees seeking roots adaptable for injection and the difficulties in making good injections in inconvenient positions overbalanced the possible advantages of the method.

Another method was tried, which was principally worked out by R. C. Walton, an assistant in the work. The method had been suggested to him by Chewyreuv's[3] Extraradicate Nutrition of Diseased Trees. The method is a simple one, easily and quickly applied. A hole 2 inches by 1 inch was cut in the side near the bottom of a tin can, such as is used in canning vegetables. A lump of grafting wax of such consistency that it can be softened in one's hands was put on the trunk where the injection was to be made. The wax was pushed into the crevices of the bark and worked away from the center, until a space was cleared of the same size as the hole in the tin can. The can was then placed against the tree trunk so that the edge of the hole fitted the ridge of wax and the can was then bound in place with string (fig. 1). The object was to make a water-tight joint. The solution to be injected was poured into the can. The cut in the tree was then made by driving a quarter-inch chisel deep into the tree trunk, the chisel having been inserted from the top of the can through the hole cut in its side.

The disadvantages of this method are that the metal of the container

[1] Formerly Expert, Office of Investigations in Forest Pathology, Bureau of Plant Industry.

[2] Goff, E. S. Wisconsin Agr. Exp. Sta. Report **14:** 272–282. 1897.

[3] Chewyreuv, Ivan. Extraradicate nutrition of diseased trees. Records of the Botanical Division. St. Petersburgh Imperial Soc. of Naturalists. Conference of 1894.

reacts on the solutions and the grafting wax is likely to give way, allowing the solution to leak away. The interior of the tin can might be plated with an inert substance, or a glass container substituted. This latter device was tried. A hole was made in a Mason glass jar with hydrofluoric acid. The method of injection was the same as when the tin can was used except that the jar was placed on a small shelf fastened to the tree as well as tied against the trunk. The unreliability of grafting wax for making joints still remained a serious disadvantage, when the jars remained attached to the trees for several days.

Another method which does not depend on grafting wax for connections was devised by W. T. Bovie, an assistant in the work. This method is simple in design, easily applied, and does not need to be watched. A tin box was made which was 6 inches long, 4 inches deep, and 3.78 inches wide, open at the top and at one end (fig. 2, *a*). The box was placed with its open end in contact with the tree trunk and made fast by a copper wire wrapped around both the box and the trunk (fig. 2). Melted grafting wax was next applied to the edges of the box where it came in contact with the tree. If the wax is worked as it cools, a water-tight joint can be obtained easily. The tree trunk should be as free from wax as possible and yet the joint should be tight. The box was filled with water. This box is for the purpose of enabling one to cut a hole in the trunk without letting air enter the tissues of the tree. A glass (self-sealing) fruit jar (fig. 7, *b*) containing the solution to be injected was hung by a hook (fig. 7, *a*) in the tree above the point of injection. It was closed at the top by a cap of parchment paper (butter paper). A rubber tube (fig. 3, *a;* fig. 7, *c*) (glass tubes can be used if necessary), acting as a siphon, led the solution down to the point of injection. If rubber tubing is used, a short glass tube is inserted in the lower end of it. The other end of the glass tube joint passed through a perforated rubber stopper, 1 inch in diameter (fig. 3, *d*), the large end of the rubber stopper being turned toward the free end of the tube. An apparatus for holding the tube in place consisted of a block of wood 6 inches by 3 inches by 1 inch (fig. 3, *c*), in the center of which a hole was bored just large enough to take the small end of the rubber stopper. Two strips of hoop-iron (fig. 3, *e* and *e'*) were nailed to the ends of the board so as to extend at right angles from it; one of these strips (fig. 3, *e*) had two rows of holes punched into it, the other (fig. 3, *e'*) a series of teeth cut along each edge. These holes and teeth were to receive wires made out of spring brass (fig. 3, *g*). The wooden blocks, the metal strips, and the brass spring together made a clamp (figs. 3, 5, 6, and 7), which held the rubber cork pressed against the tree with a total pressure of over 40 pounds. The wire used in these clamps was No. 9. The details of this clamp will be understood by referring to figure 3, which is

a view looking down on a tree cut off at the point of injection. By having a number of holes and notches the clamps were adjustable to different sized trees. In a second series of clamps, larger than the first, there were blocks of wood which measured 9 inches by 3 inches by 1 inch and the strips of hoop iron nailed to the ends of the boards measured 9 inches also. The rubber tube must be passed through the hole in the clamp before the rubber stopper is put on. A clamp on the rubber tube will be found very convenient. It should be of the sort that can be removed after the connections are made.

One other device was helpful (necessary if working alone) in getting a water-tight connection. This was a piece of wood about 2 feet long fashioned into a handle, at one end of which a metal strip was fastened. This strip was at right angles to the wood and a notch was cut in the end which would just fit the rubber stopper at its middle (figs. 4 and 5). The wooden stick and metal together, wired to the tree, formed a bent lever and pressing down the handle with one's body forced the stopper against the tree (fig. 4). When all the apparatus was ready, the rubber tube was filled with solution and clamped off. A hole, varying in diameter according to need, was then cut with a one-fourth inch gouge into the tree under the surface of the water in the tin box. Care must be taken to have clean cuts at the top and bottom of this hole. The stopper was placed over the hole with the end of the glass tube entering it and held in place with the bent lever. The clamp was removed from the tube and the solution allowed to flow out around the stopper. When all the air bubbles were out of the tube, the flow was stopped by pressing down on the handle of the bent lever. The tin box was then removed and the clamp slipped around the tree (fig. 5). As soon as this was made fast, the bent lever was removed and the connections were then complete (figs. 6 and 7).

It is understood that the rubber stopper does not enter the hole in the tree; it is pressed against the outside of the tree so as to make a water-tight joint. It may be necessary in some cases to smooth the bark of an old tree with an axe or a knife before applying the tin box.

On finally removing the clamp after injection was completed, the wound was covered with grafting wax or painted.

Two conditions were found which greatly influenced the rate at which the trees took in the solutions when they were injected into the trunk. 1. The hole in the tree should be cut in such a way that air cannot get into it. 2. The hole should be clean cut. At first the holes were bored with freshly sharpened bits, but the solutions did not go in as rapidly as when a sharp chisel or gouge was used.

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EXPLANATION OF PLATE XIII

FIG. 1. Tin can method of injection.

FIG. 2. First step in Bovie's method of injection. *a*, A metal box open at top and at one end, made fast to tree with grafting wax and copper wire and filled with water.

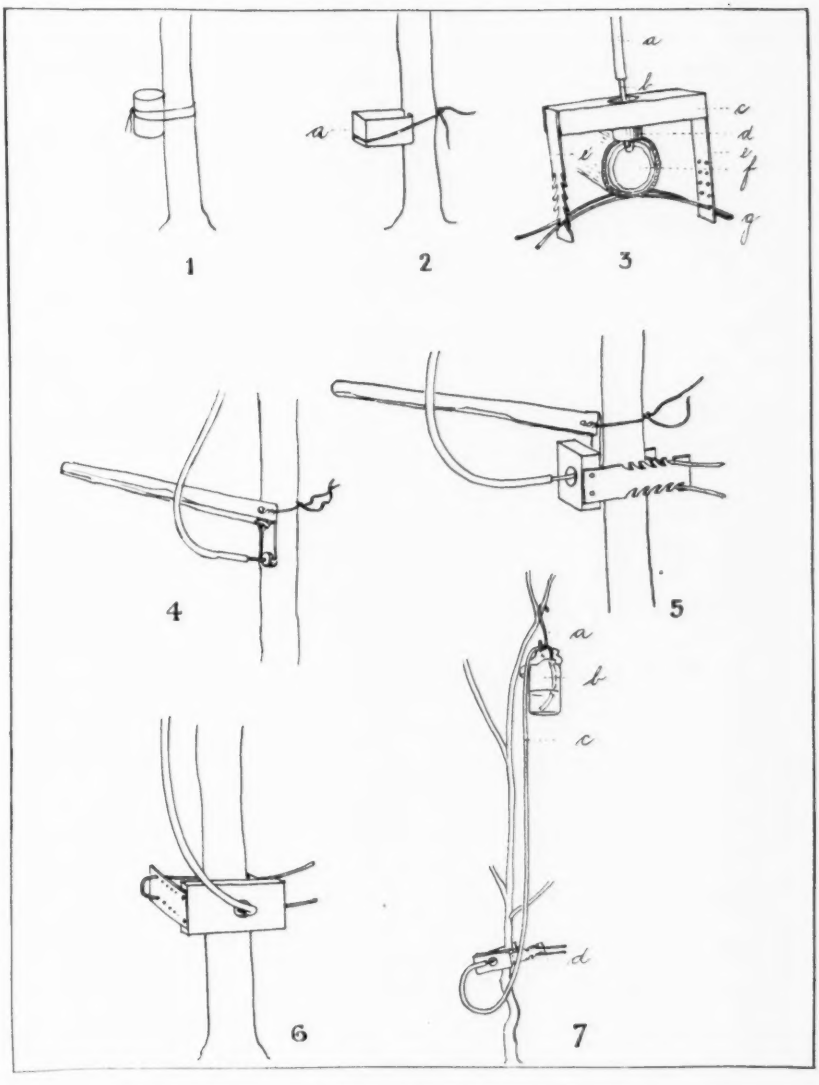
FIG. 3. View of clamp holding the tube in place at the point of injection. *a*, rubber tube leading solution to the tree; *b*, glass tube; *c*, *e*, *e'*, *g*, clamp (*c*, block of wood; *e*, e', strips of metal; *g*, brass wire); *d*, rubber stopper; *f*, cross section of tree trunk.

FIG. 4. Bent lever holding the rubber stopper and tube in position, so that the clamp can be adjusted to the tree.

FIG. 5. Clamp adjusted to tree. Bent lever holding the rubber stopper in place.

FIG. 6. Front view of clamp; bent lever removed and preparations for injection complete.

FIG. 7. A tree being injected. *a*, Hook; *b*, jar containing the solution, capped with parchment paper; *c*, rubber tubing; *d*, clamp.



RUMBOLD: METHODS OF INJECTING TREES

RAZOUMOFSKYA TSUGENSIS IN ALASKA

JAMES R. WEIR

The mistletoe, *Razoumofskya tsugensis* Rosend., which at present is known to attack only *Tsuga heterophylla* and *T. mertensiana* in the West recently has been sent to this laboratory from Alaska. The specimens were collected by Forest Examiner, G. L. Drake, on *T. heterophylla* near Tenakee, Chichagoff Island, Tongass National Forest. This is the first record of its occurrence in Alaska and extends its range practically to the most northern limit of its hosts. The late Mr. J. F. Pernot, United States Forest Examiner, supplied this laboratory with a specimen of *R. tsugensis* on *T. heterophylla*, labeled "vicinity of Lake of the Woods, Oregon." This is the farthest point south in the range of the host from which specimens have been procured. The writer has collected this mistletoe on *T. mertensiana* in the Coeur d'Alene Mountains, in Idaho, and *T. heterophylla* in several localities in Idaho, Washington and British Columbia. A collection on the latter host from the Lolo National Forest, east slope of the Bitterroot Mountains, Montana, extends the range of the parasite farther to the east than has been reported heretofore. It may be assumed that *R. tsugensis* extends throughout the entire range of its two known hosts. So far as known, it is of economic importance only in certain districts of Washington, Idaho and Alaska. Mr. Drake states that in some sections of the Tongass National Forest "the percentage of infection varied from 30 to 80 per cent of the stand" and is a serious menace to the best growth of the hemlock forests. Injury to the host results from the formation of large burls on the trunk, also the branches become heavily broomd which causes them to break off under the stress of high winds or snow. This causes a serious retardation of growth and exposes such trees to attacks by fungi and insects.

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THE CONTROL OF CEREAL AND GRASS SMUT AND THE HELMINTHOSPORIUM DISEASE IN HOLLAND AND GERMANY

OTTO APPEL

Quanjer and Botjes[1] have published the results of new experiments on cereal and grass smuts and the Helminthosporium disease and have come to the conclusion that spraying with a solution of 200 grams copper sulphate per 2 to 2.5 liters of water for each hectoliter of wheat seed, gives the best results in the control of stinking smut. The authors are wrong, however, in saying that this method is impractical in Germany. On the contrary, it is much used. It is not recommended, however, because under the conditions prevailing in Germany, it has some disadvantages. One of these is that in dry summers the wheat is so brittle that in threshing the kernels are cracked and such kernels are slightly injured by the copper sulphate. To prevent this the seeds are afterward treated with milk of lime. According to Quanjer, a smaller amount of a strong solution causes less injury than a larger quantity of a weak solution, which explains, perhaps, the failure of this method in many earlier experiments. The other and more important reason why this method is not recommended in Germany is the lack of success in many cases. With wheat with a thin seed coat the diseased kernels are all or nearly all crushed by threshing, and as a result the smut spores are scattered all over the surface of the sound seeds and are, therefore, easily killed by this method of treatment. On the other hand, with wheat having a harder seed coat the diseased kernels are not crushed and therefore the copper sulphate does not penetrate beneath the surface and kill the spores. When sown with a machine these kernels are crushed and the uninjured spores cause a new infection of the treated seeds. Since we, in Germany, use many varieties of wheat with hard seed coats, the spraying method is not universally applicable and therefore methods are to be recommended in which either all the entire diseased kernels are floated out before treatment as in v. Tubeuf's method, or in which substances like formaldehyde are used, which act more upon the spores in the interior of the kernels.

[1] Quanjer, H. M. en Botjes, I. Oortiwjn. Nederlandsche onderzoekingen over de bestrijding van Grann-en Grasbrand en ven Strepenziekte. Mededeelingen van de Rijks Hoojere Land—, Tuin—en Boschbouwschool, **8**: H. 26, 129–160, pl. III–V. 1915.

The formaldehyde treatment gives good results in general in Germany, while Quanjer had less success with it. In the first place Quanjer found that the young plants developed more slowly after the formaldehyde treatment. This seeming injury appears to me to be due to the fact that the seed which Quanjer has used was not normal. In the untreated plots of the three winter wheats used (Wilhelmina, Witte Dikkopp, and Grenadier), only 21, 10, and 28 per cent germinated in the soil; of the summer wheat 78 per cent germinated between blotting papers and 50 per cent in the soil. But it is well known that bad seed is more sensitive than good seed. For this reason we generally use in Germany wheat which has a germination percentage of 98 to 100. Wheat, less than 90 per cent of which germinates, is used by us only in case of necessity. That poor seed is less injured by copper, especially in the form of Bordeaux mixture, than by formaldehyde is shown by our experiments.

The good results with formaldehyde have been confirmed in 1914, both in practice and by the experiments carried on by my collaborator, Dr. E. Riehm.[2] When we try new control measures in Germany, it is not because, as Quanjer assumes, our former methods were unsatisfactory, but in order to determine the value of new fungicides recommended by commercial houses, and also for the purpose of finding a means of combatting several diseases at the same time, as in the case of *Tilletia tritici* and Fusarium on wheat and rye and *Ustilago tecta* and Helminthosporium on barley.

Riehm's experiments have proved that a treatment of the seeds by a 0.1 per cent solution of mercuric salt of monochlorophenol (chlorphenolquecksilber) for ten minutes is as effective as formaldehyde against stinking smut, but anilin dyes and chinosol are less satisfactory.

Chlorphenolquecksilber and chinosol may be used with good results in case of a light attack by Helminthosporium; in the severe attack occurring in 1912, copper sulphate was more effective than formaldehyde but did not stamp out the disease entirely.

For the control of Fusarium all the fungicides are equally effective, i.e., a submersion of the seed for 15 minutes in a 0.1 per cent solution of formaldehyde, chinosol, corrosive sublimate, or chlorphenolquecksilber. This treatment only diminishes the disease, however. The effectiveness of the treatment depends upon the amount of penetration of the fungus into the seed. If infection has taken place during the milk stage, or when mature seed has been subjected to an extended period of excessive moisture, then no chemical means of prevention are effective so far as known.

[2] Riehm, E. Beizversuche zur Bekämpfung einiger Getreidekrankheiten. Illustr. landw. Ztg. **35**: 161–162. 1915.

For America, with its enormous wheat fields, Quanjer's method is to be recommended on account of its simplicity, when the wheat contains no unbroken smut kernels. I would rather recommend, however, Tubeuf's method, using Bordeaux mixture instead of copper sulphate because these less readily soluble copper salts act longer than the easily soluble copper sulphate.

The Danish hot water method in its modified form is, according to Quanjer, of value as a preventive measure against *Ustilago nuda*, *U. hordei*, *U. tritici*, *U. avenae*, *U. bromivora*, and *Helminthosporium*. I call attention to the fact here that in Germany we have obtained striking results with formaldehyde in the prevention of oat smut which does not attack the flowers but infects the seedlings. Naturally, the formalin treatment cannot be used in the case of smuts attacking the flowers.

BERLIN-DAHLEM
GERMANY

THE CHESTNUT BARK DISEASE ON FRESHLY FALLEN NUTS

J. Franklin Collins

With One Figure in the Text

The writer has called attention[1] to the finding of the chestnut bark disease on old nuts and burrs of the Paragon chestnut, in Lancaster county, Pennsylvania, in 1912. This discovery suggested the possibility that the disease might at times be found in freshly fallen nuts, but no opportunity occurred until the fall of 1913 to examine fresh nuts grown in a region where the disease was prevalent.

In Delaware, on October 23 and 24, 1913, freshly fallen nuts of several cultivated varieties were found which had well-marked blister-like excrescences (fig. 1) under the tough outer skin. Several nuts showing these excrescences were found under two Ridgely trees near Dover, and under one Ridgely, one "Spanish," one Numbo, and one Dager tree at Felton. Under one tree some of the diseased nuts were still attached to the opened burrs, and in one case they were found in a burr which had not yet fallen from the tree.

Cultures were attempted from all six of these sources, mainly from the interior of the blister-like excrescences. Although a rather hasty examination of the kernel of one nut from each of the six sources mentioned revealed fungal hyphae in five of them, no attempt was made to get cultures. No cultures were obtained from the excrescences on the nuts of one Ridgely tree, and the cultures from the Dager and "Spanish" nuts became contaminated, or were not typical, and were discarded. Cultures from the other three nuts—obtained from (a) the original old Ridgely tree near Dover, (b) a young Ridgely tree at Felton, and (c) a Numbo tree at Felton—resembled typical pure cultures of the chestnut bark disease fungus, *Endothia parasitica* (Murr.) And.

Inoculations were made from the three cultures last mentioned. Those from the old Ridgely tree and the Numbo tree were made on May 26, 1914, and those from the Ridgely tree at Felton on July 31, 1914. The method of inoculating was the same in each case; nine cuts were made along the side of an American chestnut sprout, the three lowest to the wood, the next three to the middle bark, and the upper three were little

[1] Science **38**: 857-858. December 12, 1913.

more than scratches through the outer layers of the bark. No attempt was made to inoculate with spores alone, nor with mycelium alone; undoubtedly all inoculating media contained both. Nine check cuts with a sterile knife were made on the opposite side of each sprout, one cut opposite each inoculated cut, and practically identical with the latter as regards depth and character of cut. The usual precautions were taken to have the knife and other implements sterile.

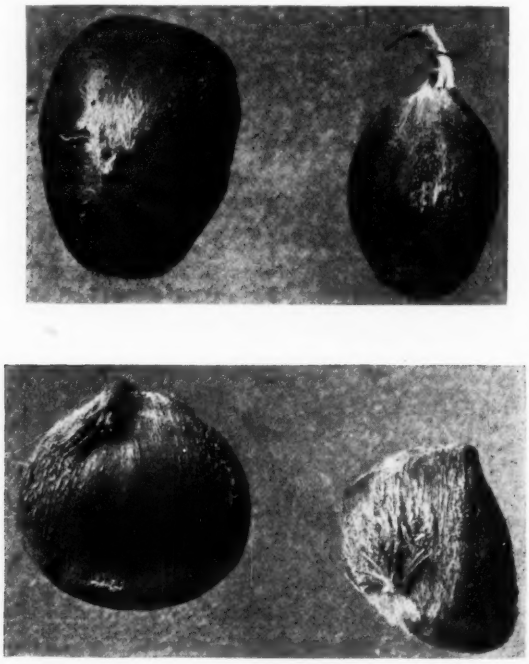

FIG. 1. Four cultivated chestnuts showing blister-like excrescences of the chestnut bark disease. Natural size.

At the date of the last observation, January 8, 1915, the six lowest cuts in each series of inoculations had developed typical lesions of the chestnut bark disease, varying from one to four inches in diameter, while the three upper cuts (scratches) and all the check cuts failed to show any signs of disease.

The failure of attempts to inoculate through scratches in the surface of the bark has been a noticeable feature of similar attempts in the past, although they have not always been as definite and well-marked as in the present instance.

The results mentioned above may be summarized and tabulated as follows:

NAME OF VARIETY	INOCULATIONS	CHECKS	RESULTS
Ridgely (old tree)	3 to wood		all infected
	3 to middle bark		all infected
	3 scratched		none infected
		9	none infected
Numbo	3 to wood		all infected
	3 to middle bark		all infected
	3 scratched		none infected
		9	none infected
Ridgely (young tree)	3 to wood		all infected
	3 to middle bark		all infected
	3 scratched		none infected
		9	none infected

The data obtained from these cultures and inoculations show conclusively that nuts are sometimes infected with the chestnut bark disease before they fall from the tree. Most of the nuts collected in 1913 had considerably fewer and less conspicuous blister-like excrescences than the four shown in the accompanying illustration. Otherwise, as viewed externally, they appeared to be normal and healthy, and undoubtedly would readily be passed by the ordinary shipper as sound and marketable nuts. Under such conditions it would be within the range of possibility to introduce the disease into a new locality by means of the discarded shells or kernels of the diseased nuts.

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PHYTOPATHOLOGICAL NOTES

A way of obtaining an abundance of large uredinia from artificial culture. While engaged in wheat rust cooperative work with the Office of Cereal Investigations, Washington, D. C., a most satisfactory method was found for propagating rust cultures on an extensive scale. When one is engaged in a particular line of rust investigational work which requires an accumulation of uredo-material for spraying purposes, the material which is required must be produced in considerable quantities, and this requires a great deal of time and patience. Since the rust must be grown upon the host itself, it is desirable that each inoculation produce an abundance of sori, and that these be as large as possible.

Ordinarily, hand inoculations are made by scraping the spores from a leaf bearing them, using a flattened needle moistened in distilled water. The spores are generally placed in a drop of water which is attached to the back of the leaf blade near its base. Those who have been engaged in this kind of work realize the difficulty involved in attaching this drop of water, or in wetting the surface of the leaves of grasses sufficiently to get the spores to adhere. This method is a tedious one, especially when it is necessary to make hundreds of inoculations. The writer has also observed that the sori which develop from the attached drop method are often very limited in size and number.

The method which we have followed in propagating *Puccinia graminis tritici* on a large scale for field spraying purposes, where the testing of wheats resistant to the black stem rust is carried on, is as follows: Potted wheat seedlings from a few days up to two weeks old are employed. In addition to these, a dish of distilled water, a curved dissecting needle, or a flattened needle, and viable uredospores, are the necessary materials. The surfaces of the leaves to be inoculated are thoroughly wetted by passing the leaf blades between the thumb and index finger which have been dampened in the dish of water. Pass the leaves between the thumb and finger several times so as to cause a film of water to adhere to the entire leaf surface. By means of the transferring needle, apply the spores from the material bearing them, to the upper surface of the leaf to be inoculated. Pass the needle back and forth over the entire surface so as to spread the spores over the leaf blade. It is more convenient to inoculate the under surface of wheat leaves and the results are very satisfactory. Although there are only half the number of stomata on the

under surface, in the case of wheat, there seems to be little difficulty in securing an abundance of infection.

Inoculated plants should be immediately placed into damp chambers in the ordinary manner, and allowed to remain there for forty-eight hours. At the end of this time they should be removed and placed on a greenhouse bench containing soil or preferably sand.

The sand and potted plants should be kept damp. It is found that galvanized iron trays, 35 inches x 17 inches x ½ inch are most satisfactory to set the seedlings into after having come out of the damp chamber. These pans can be flooded with water and in this way there is no danger in losing the uredospores in watering, for it is possible to water the pots without touching the leaves.

It is not necessary to supply shade, unless it becomes very bright. It generally requires from ten days to two weeks for sori to appear. Although this method would not be advisable or satisfactory where one wishes to eliminate all possible chances of contamination, it is the only practical method for growing rust material on an extensive scale, for such purposes as mentioned above. In using the above method, the writer never failed to secure an abundance of large sori which extend over the entire leaf surface.

LEO E. MELCHERS

Sweet pea powdery mildew. The appearance of a recent bulletin on the diseases of the sweet pea, by Taubenhaus[1] in which the powdery mildew of the sweet pea is referred to as "*Erysiphe polygoni?*" leads the writer to state that on September 27, 1910, he collected from the horticultural garden of the College of Agriculture, Ithaca, N. Y., leaves of the sweet pea which bore perithecia of *Microsphaera alni* (Wallr.) Salm. Many of the perithecia were immature with the appendages not well developed so that they might easily be mistaken for *Erysiphe polygoni*. A number of mature perithecia were found, however, typical in all respects of *Microsphaera alni*.

The writer has also had the privilege of examining an excellent specimen in the collection of the New York (Geneva) Experiment Station, which was collected by John L. Sheldon at Lincoln, Nebraska, in October, 1902, and determined by him as *Microsphaera alni* (Wallr.) Salm. on *Lathyrus odoratus*.

F. M. BLODGETT

[1]Taubenhaus, J. J. The diseases of the sweet pea. Delaware Agr. Exp. Sta. Bul. 106: 38–40.

Personals. Mr. Max W. Gardner, of the University of Wisconsin, has been appointed as Field Assistant in Pathology in the Bureau of Plant Industry and will be stationed at Princeton, Wisconsin, to conduct cooperative cucumber disease investigations. Corresponding positions in Michigan and Indiana will be taken by Mr. Raymond C. Rose, of Minnesota, and Dr. Geo. A. Osner, of New York, with headquarters at Big Rapids, Michigan, and Plymouth, Indiana.

Mr. J. T. Rogers was transferred on March 25, 1915, from the position of Agent in Forest Pathology, Bureau of Plant Industry, to that of Assistant Pathological Inspector, Federal Horticultural Board.

Dr. F. L. Stevens, Professor of Plant Pathology, of the University of Illinois, is engaged during the summer in a Biological Survey of Porto Rico, collecting and studying tropical plant diseases and fungi. He sailed June 5 accompanied by Mrs. Stevens and by several students.

W. Ralph Jones. The death is announced of Dr. W. Ralph Jones, Scientific Assistant in Plant Pathology, Office of Fruit Disease Investigations, Bureau of Plant Industry, which occurred on May 17, 1915, at the age of 32 years. Dr. Jones graduated from the collegiate department of Johns Hopkins University in June, 1911, and had previous to that time been a teacher in the Baltimore City College, and in the Louisiana Industrial Institute, Ruston, Louisiana. He entered the Department of Agriculture in 1911 and had since that time been engaged with Dr. C. L. Shear in a study of the diseases of small fruits. He was a member of the American Phytopathological Society.

LITERATURE ON AMERICAN PLANT DISEASES[1]

COMPILED BY MISS E. R. OBERLY, LIBRARIAN, BUREAU OF PLANT INDUSTRY

April–May, 1915

Anderson, Jacob Peter. Some observations on sycamore blight and accompanying fungi. Proc. Iowa Acad. Sci. **21**: 109–114, pl. 7–8. 1914.

Also issued as Contr. Bot. Dept. Iowa State Col. Ames, no. 56.

Gnomonia veneta.

Accompanying fungi: *Coniothyrium mixtum; Cytospora platani; Massaria platani.*

Anderson, Paul Johnson, and **Babcock, D. C.** Field studies on the dissemination and growth of the chestnut blight fungus. Pennsylvania Chestnut Tree Blight Com. Bul. 3, 45 p., 14 pl. [1915.]

Title page bears date 1913. Actually issued 1915.

Endothia parasitica.

Appel, Otto. Disease resistance in plants. Science n. s. **41,** no. 1065: 773–782. May 28, 1915.

——— The relations between scientific botany and phytopathology. Ann. Missouri Bot. Gard. **2,** no. 1/2: 275–285. February/April, 1915.

Arthur, Joseph Charles. Cultures of Uredineae in 1912, 1913 and 1914. Mycologia **7,** no. 2: 61–89. March, 1915.

Beattie, Rolla Kent. Bibliography of the chestnut bark disease. Final Rpt. Pennsylvania Chestnut Tree Blight Com. **1913:** 97–121, 1 pl. 1914.

Also reprinted. Reprint noted in previous list.

Bessey, Ernst Athearn, and **Byars, L. P.** The control of root-knot. U. S. Dept. Agr. Farmers' Bul. 648. 19 p., 20 fig. 1905.

Heterodera radicicola.

Blake, Maurice A. Observations upon a disease of carnations. New Jersey Agr. Expt. Sta. 34th Ann. Rpt. [**1912**]/**13**: 168–170. 1914.

Leaf spot. Cause unknown.

Blodgett, Forest Milo. Further studies on the spread and control of hop mildew. New York State Agr. Expt. Sta. Bul. 395: 29–80, 2 fig., 2 pl. 1915.

Sphaerotheca humuli.

Partial contents: Observation of life history of the fungus; use of sulphur in control of mildew.

Caesar, Lawson. Report [on plant diseases]. Ann. Rpt. Dept. Agr. Ontario **1913,** v. 1: 28–31. 1915.

[1] This list aims to include the publications of North and South America, the West India Islands, and islands controlled by the United States, and articles by American writers appearing in foreign journals.

All authors are urged to coöperate in making the list complete by sending their separates and by making corrections and additions, and especially by calling attention to meritorious articles published outside of regular journals. Reprints or correspondence should be addressed to Miss E. R. Oberly, Librarian, Bureau of Plant Industry, U. S. Dept. Agric., Washington, D. C.

Carleton, Mark Alfred. The fight to save the chestnut trees; final report of the general manager. Final Rpt. Pennsylvania Chestnut Tree Blight Com. **1913:** 27–60, pl., maps. 1914.

Cunningham, G. C. Studies of club-root. II. Disease resistance of crucifers: methods of combatting club-root. Vermont Agr. Expt. Sta. Bul. 185: 67–96, 9 pl. 1914.

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Detwiler, Samuel B. Observations on sanitation cutting in controlling the chestnut blight in Pennsylvania. Final Rpt. Pennsylvania Chestnut Tree Blight Com. **1913:** 63–94, pl., maps. 1914.

Endothia parasitica.

Du Porte, E. Melville. The downy mildews. 6th Ann. Rpt. Quebec Soc. Prot. Plants **1913/14:** 33–38, illus. 1914.

"Key to common genera of Peronosporaceae," p. 38.

Peronospora trifoliorum, Phytophthora infestans, Plasmopara viticola.

Edson, Howard Austin. Seedling diseases of sugar beets and their relation to root-rot and crown-rot. Jour. Agr. Research **4,** no. 2: 135–168, pl. 16–26. May, 1915.

Literature cited, p. 165–168.

Phoma betae; Rhizoctonia sp., probably identical with *Corticium vagum* B. and C., var. *solani* Burt; *Pythium debaryanum;* undescribed member of Saprolegneaceae.

Florida. Laws, Statutes, etc. Passage of the plant act bill. Florida Grower **11,** no. 31: 6–7. May 1, 1915.

——— Proposed Florida plant act of 1915. Florida Grower **11,** no. 29: 12–13. April 17, 1915.

Fraser, W. P. Notes of some plant diseases of 1913. 6th Ann. Rpt. Quebec Soc. Prot. Plants **1913/14:** 45–50, illus. 1914.

Peronospora trifoliorum, Sclerotinia trifoliorum, Nectria galligena, Ascochyta pisi, Septoria pisi, Ustilago panici-miliacei, Helminthosporium gramineum, tip-burn of potato, tomato blossom-end rot, *Coniothyrium Fuckelii.*

——— Storage rots of potatoes and other vegetables. 6th Ann. Rpt. Quebec Soc. Prot. Plants **1913/14:** 50–51. 1914.

Freeman, Edward Monroe. Fire blight—some facts of history. Minnesota State Hort. Soc. Trans. **1914:** 338–341, 2 fig. 1914.

Discussion, p. 341–351.

Bacterium sp.

Fromme, Fred Denton. Negative heliotropism of urediniospore germ-tubes. Amer. Jour. Bot. **2,** no. 2: 82–85, 2 fig. February, 1915.

George, D. C. The yellow blight of the tomato. Washington Agr. Expt. Sta. Pop. Bul. 82, 4 p. 1915.

Guimarães, Renato Ferraz. Molestias e parasitas das plantas e seu tratamento. Bol. Agr. [São Paulo] **15,** no. 11/12: 1004–1009, Novembro/Dezembro, 1914; **16,** no. 1: 45–47, Janeiro, 1915. 1914–15.

Parts 1 and 2 appeared in Bol. Agr. [São Paulo] **15,** no. 6/7: 445–460, Junho/Julho; no 8/10: 773–776, Agosto/Outubro. 1914. Noted in previous list.

Harrison, Francis Charles, and **Sadler, Wilfred.** A bacterial soft rot of turnips. 6th Ann. Rpt. Quebec Soc. Prot. Plants **1913/14:** 59–72, 15 fig. 1914.

Part of article, previously noted, in Proc. and Trans. Roy. Soc. Canada III, **7** (1913), sect. 4: 91–106, 5 pl. 1914.

"We have worked out in detail the pathogenicity of an organism belonging to the soft rot type . . . and have described its morphological and cultural features in detail."

Harter, Leonard Lee. Notes on the distribution and prevalence of three important sweet potato diseases. Phytopathology **5,** no. 2: 124–126. April, 1915.

Stem rot (*Fusarium hyperoxysporum* and *F. batatatis*); black rot (*Sphaeronema fimbriatum*); foot rot (*Plenodomus destruens*).

Hartley, Carl. Injury by disinfectants to seeds and roots in sandy soils. U. S. Dept. Agr. Bul. 169, 35 p., 2 fig., 1 pl. 1915.

Hasse, Clara H. Pseudomonas citri, the cause of citrus canker. A preliminary report. Jour. Agr. Research **4,** no. 1: 97–100, pl. 9–10. April, 1915.

Hawkins, Lon Adrian. Some effects of the brown-rot fungus upon the composition of the peach. Amer. Jour. Bot. **2,** no. 2: 71–81. February, 1915.

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Sclerotinia cinerea.

Headden, William P. Yellow-berry in wheat, its cause and prevention. Colorado Agr. Expt. Sta. Bul. 205, 38 p., 1 pl. 1915.

Physiological disease probably due to soil conditions.

Hoffer, George N. The more important fungi attacking forest trees in Indiana. 14th Ann. Rpt. State Bd. Forestry [Indiana] **1914:** 84–97, 5 fig. 1915.

Trunk-attacking fungi, foliage-attacking fungi, root-attacking fungi.

Horne, William Titus. Oak fungus or Armillaria mellea in connection with nursery stock. Mo. Bul. State Com. Hort. [California] **4,** no. 4: 179–184, fig. 31–33. April, 1915.

Howard, Walter Lafayette. Profits from spraying twenty-five Missouri orchards in 1914. Missouri Agr. Expt. Sta. Bul. 124: 187–285, 5 fig. 1915.

Howe, G. H. Effect of various dressings on pruning wounds of fruit trees. New York State Agr. Expt. Sta. Bul. 396: 83–94. 1915.

Howitt, J. Eaton. Experiments in the control of late blight of celery. Ann. Rpt. Dept. Agr. Ontario **1913,** v. 1: 45–46. 1915.

——— Notes on the apothecial stage of Sclerotinia cinerea in Ontario. Ann. Rpt. Dept. Agr. Ontario **1913**, v. 1: 47–49, 1 fig. 1915.

Published also in Ottawa Nat. **27,** no. 11: 158–160. February, 1914. Noted in previous list.

——— [Plant diseases in Ontario.] Ann. Rpt. Dept. Agr. Ontario **1913**, v. 1:35–38, 2 fig. 1915.

——— Spraying experiments to prevent rose-leaf blotch. Ann. Rpt. Dept. Agr. Ontario **1913,** v. 1: 46. 1915.

Actinonema rosae.

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Certificate for the despatch of horticultural plants (Appendix of the final report of the conference), p. 549–550.

Jackson, Herbert Spencer. [Report of] department of botany and plant pathology. Oregon Agr. Expt. Sta. Rpt. **1912/14:** 10–12. [1915.]

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Jamieson, Clara Octavia. Phoma destructiva, the cause of a fruit rot of the tomato. Jour. Agr. Research **4,** no. 1: 1–20, pl. 1–6 (2 col.). April, 1915.

Literature cited, p. 19–20.

Jehle, Robert Andrew. A common but very serious potato disease in Cuba. Modern Cuba **3,** no. 4: 46–48. April, 1915.

Phytophthora infestans.

Johnston, S. C. Celery blight experiments. 10th Ann. Rpt. Ontario Veg. Growers' Assoc. **1914:** 22–32, illus. 1915.

Excellent results from spraying with bordeaux mixture.

Jones, Lewis Ralph, and **Gilbert, William Williams.** Lightning injury to potato and cotton plants. Phytopathology **5,** o. 2: 94–102, pl. 8–9. April, 1915.

Laat, Julio E. van der. Las enfermedades del banano. Bol. Sec. Fomento [Honduras] **4,** no 1/2: 57–65, illus. Enero/Febrero, 1915.

Lipman, Charles Bernard. A suggestion of a new phase of the problem of physiological diseases of plants. Phytopathology **5,** no. 2: 111–116. April, 1915.

Presents theory of lack of nitrogen in available form as cause of physiological diseases.

McCubbin, W. A. Experimental results on peach canker. 46th Ann. Rpt. Fruit Growers' Assoc. **1914:** 28–32. 1915.

Caused by either brown rot fungus or Cytospora.

——— First report from the branch laboratory of the division of botany, St. Catharines, Ont. Canada Expt. Farms Rpts. [**1912**]/**13:** 497–498. 1914.

"This laboratory was established by the division of botany for the study of plant diseases in the Niagara district and was opened August 1, 1912."

Meinecke, Emilio Pepe Michael. Robert Hartig (1839–1901). Phytopathology **5,** no. 1: 1–3. February, 1915.

Munn, M. T. Sulphur vs. bordeaux mixture as a spray for potatoes. III. New York State Agr. Expt. Sta. Bul. 397: 95–105, 2 pl. 1915.

Lime-sulphur harmful rather than beneficial to potatoes.

Norton, Jesse Baker. Making a new variety of asparagus. Trans. Massachusetts Hort. Soc. **1914,** pt. 1: 45–50. 1914.

Contains some notes on immunity of this new variety to the asparagus rust *Puccinia asparagi.*

Nowell, William. Diseases of the cotton plant in the West Indies. Imp. Dept. Agr. West Indies Pamphlet **74:** 94–109, fig. 32–35. 1914.

——— Two physiological affections of Sea Island cotton in the West Indies. West Indian Bul. **14,** no. 4: 304–317, illus. 1914.

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Pammel, Louis Hermann, King, Charlotte M., and **Seal, J. L.** Corn stalk and corn root diseases in Iowa. Iowa Agr. Expt. Sta. Circ. 21, 8 p., 2 illus. 1915.

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Pennsylvania Chestnut Tree Blight Commission. Final report. January 1 to December 15, 1913. 121 p., pl. Harrisburg, Pennsylvania, 1914.

Pool, Venus Worrell, and **McKay, Marion B.** Phoma betae on the leaves of the sugar beet. Jour. Agr. Research **4,** no. 2: 169–177, pl. 27. May, 1915.

Relationships of *Phoma betae* and *Phyllosticta betae.*

Rangel, Eugenio. Fungos parasitas do guando (Cajanus indicus, Spreng.). Bol. Agr. [São Paulo] **16,** no. 2: 145–156. illus. Fevereiro, 1915.

Reddick, Donald. [Report of committee on] botany and plant diseases. Serious diseases of the past season. West. New York Hort. Soc. Proc. 60th Ann. Meeting **1915:** 78–81. [1915.]

Reddick, Donald and **Crosby, C. R.** Comparative dusting and spraying experiments. West. New York Hort. Soc. Proc. 60th Ann. Meeting **1915:** 68–77. [1915.]

——— Further experiments in the dusting and spraying of apples. New York Cornell Agr. Expt. Sta. Bul. 354: 53–96, fig. 16–32. 1915.

Reed, Howard Sprague, and **Grissom, J. Thomas.** The development of alkalinity in Glomerella cultures. Jour. Biol. Chem. **21,** no. 1: 159–163. May, 1915.

Rees, H. L. Apple anthracnose or black spot canker. West. Washington Agr. Expt. Sta. Mo. Bul. **2,** no. 7: 12. October, 1914.

——— Control of damping-off fungi. West. Washington Agr. Expt. Sta. Mo. Bul. **3,** no. 1:15–16. April, 1915.

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[PHYTOPATHOLOGY, for June, 1915 (**3**: 133–212, Pls. X–XII), was issued June 4, 1915.]